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Brief 65-10303

NASA TECH BRIEF

Nickel Solution Prepared for Precision Electroforming

The problem: Lightweight, precision optical reflectors, such as parabolic mirrors required for solar energy concentrators, have been fabricated by electroforming of nickel on masters. In order to avoid internal stresses and maintain the dimensional accuracy of the electrodeposited metal, it is essential to choose the proper electrolytes and control the composition of the plating bath within narrow limits during the entire electroforming process.

The solution: A prescribed series of steps for preparation of the plating bath, process-control testing, and adjustment of the bath composition.

How it's done: Nickel sulfamate is used as the electrolyte for the electroforming process. The nickel sulfamate, admixed with nickel chloride and boric acid, is available from commercial sources as a water concentrate (Sulfamate Nickel) having a pH of approximately 4.0.

The plating solution is prepared in a clean transfer tank. A volume of distilled water equal to one-third the volume of the final solution is added to the tank, followed by addition of the nickel concentrate to bring the volume to three-fourths of the final volume. The temperature of the diluted solution is then raised to 140°F by immersion heaters and the concentrations are adjusted to the approximately required values. Distilled water is then added to bring the solution to full volume.

The heated solution is purified by thoroughly mixing into it activated carbon (5 lb per 100 gal of solution). Mixing is continued for 4 hours using at least two impellers to provide adequate circulation. When mixing is completed, the heaters and impellers are turned off and cellulose filter-aid is added. The bath is allowed to stand for a sufficient time (approximately 2 hours) to settle the carbon and filter-aid to the bottom. At the end of the settling period, a sample of the supernatant solution is drawn off for analysis. The composition of the solution is adjusted in accordance with the results of the analysis to the following concentrations:

pH, 4.7 ±0.2
Nickel (Ni), 12.5 to 13.0 oz/gal
Chloride (Cl), 0.6 ±0.1 oz/gal
Boric Acid, 4.7 ±0.2 oz/gal

The solution is then filtered into a clean plating tank. A sample (2 to 3 gallons) of this solution is then taken to determine the internal stress of the nickel electrodeposited on strips over a range of current densities. The sample is adjusted to the desired minimum stress value by the addition of sufficient stress reducer (from commercial sources) as indicated by further strip tests. A proportionate amount of stress reducer is then added to the main solution in the plating tank. A wetting (antipitting) agent may also be dissolved into the plating solution. The correct amount of wetting agent has been added when a 5-inch metal hoop remains wetted for 2 to 3 seconds after immersion in the solution. The bath is then ready for use.

During the electroforming process, undesirable metal ions are removed from the solution by a dummy cathode which operates continuously at a current density of approximately 3 amperes per square foot. Before each electroforming operation, the plating solution is tested and adjusted accordingly.

Note: Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
Western Operations Office
150 Pico Boulevard
Santa Monica, California, 90406
Reference: B65-10303

(continued overleaf)

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated by NASA.

Source: Electro-Optical Systems, Inc under contract to Western Operations Office (W00-070)